AMENDMENTS TO THE CLAIMS:

This listing of the claims will replace all prior versions, and listings, of the claims in this application.

Listing of Claims:

1.   (currently amended) A multi-level space-time signal constellation stored by a computer readable storage media, comprising:

a first level of a signal constellation defining at least one point

a second level of the signal constellation defining a plurality of points, wherein a distance between a point defined by the second level and a nearest point defined by the first level is a maximized minimum distance between conditional distributions, and

the signal constellation defines C points and an average power that is greater than or equal to a sum of the squares of the absolute value of each point divided by the number C.

2.   (original) The multi-level space-time signal constellation of claim 1 wherein the distance between conditional distributions is a Kullback-Leibler distance.

3.   (original) The multi-level space-time signal constellation of claim 1 wherein at least one of the first and second levels define spheres.

4.   (original) The multi-level space-time signal constellation of claim 1 in combination with a two-stage detector that determines which level best matches a received symbol and which point within a level best matches the received signal.

5.   (original) The multi-level space-time signal constellation of claim 1 in combination with a receiver that scales said stored signal constellation according to a signal to noise ratio of a received signal.

6.   (original) The multi-level space time signal constellation of claim 5 wherein the receiver scales said stored signal constellation such that a signal to noise ratio of a received

symbol is greater than or equal to a sum of the squares of the absolute value of each point divided by the number C.

7.   (original) The multi-level space time signal constellation of claim 1 in combination with a receiver that receives a data signal from M transmit antennas, wherein the signal constellation defines n real dimensions and $n=2M$, further wherein M is an integer at least equal to two.

8.   (original) The multi-level space time signal constellation of claim 7 wherein the data signal is dispersed over a plurality of frequency bins.

9.   (original) The multi-level space-time constellation of claim 8 wherein a receiver decision to correlate a data signal in a frequency bin to a point of the signal constellation is independent of another decision to correlate a data signal in another frequency bin to a point of the signal constellation.

10.   (original) The multi-level signal constellation of claim 9 wherein the frequency bins are defined by orthogonal frequency division multiplexing OFDM.

11.   (original) The multi-level signal constellation of claim 8 wherein the frequency bins are interleaved and a receiver decision to correlate a data signal in a frequency bin to a point of the signal constellation is not independent of another decision to correlate a data signal in another frequency bin to a point of the signal constellation.

12.   (original) The multi-level signal constellation of claim 9 wherein the frequency bins are defined by multi-carrier code division multiple access MC-CDMA.

13.   (original) A transmitter comprising:
        a storage medium for storing a multi-level signal constellation defining C points, of which at least one point defines a first level and a plurality of points define a second level,

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and a minimum inter-level distance between points is based on a maximized minimum difference between conditional probability distributions;

a mapper coupled to the storage medium for converting an input signal to a plurality of data symbols that each correspond to at least one of the constellation points;

a pilot circuit for outputting pilot symbols;

a modulator having an input coupled to an output of the mapper and to an output of the pilot circuit for modulating the data symbols and the pilot symbols in accordance with a multi-carrier transmission technique; and

at least two antennas coupled to an output of the modulator for simultaneously transmitting the modulated symbols.

14.   (original) A receiver for receiving data and pilot symbols simultaneously over multiple channels comprising:

at least one antenna;

a demodulator coupled to an output of the antenna for demodulating received symbols in accordance with a multi-carrier transmission technique,

a channel estimator coupled to the demodulator for estimating a channel of a multi-carrier system using received pilot symbols;

a storage medium for storing a multi-level signal constellation defining C points, of which at least one point defines a first level and a plurality of points define a second level, and a minimum inter-level distance between points is based on a maximized minimum difference between conditional probability distributions; and

a mapper coupled to the demodulator and to the storage medium for converting the demodulated symbols to a plurality of data signals that each alone or in combination correspond to a constellation point.

15.   (original) The receiver of claim 14 wherein the demodulator determines a maximum likelihood conditional probability distribution of the received symbols.

16.   (currently amended) The receiver of claim 15 wherein the conditional probability

distribution is

$$p\left(X_i|S_i,\hat{H}_i\right)=\mathrm{E}_{\tilde{H}_i}\left\{p\left(X_i|S_i,\hat{H}_i,\tilde{H}_i\right)\right\}=\frac{1}{\pi\left(\sigma^2+\sigma_E^2\|S_i\|^2\right)}\exp\left\{-\frac{\left\|X_i-S_i\hat{H}_i\right\|^2}{\sigma^2+\sigma_E^2\|S_i\|^2}\right\}$$

such that the detector maximizes over at least two possible values for S_i to find a transmitted

symbol wherein $.S_i$ comprises a transmitted signal vector, $\hat{H}_i$ comprises a channel estimate

matrix, X_i comprises a received signal vector, and $\tilde{H}_i$ comprises an estimation error matrix at

an ith frequency bin.

17.   (original) A mobile terminal for communicating over a fast fading, multi-carrier

wireless channel, comprising:

        a demodulator for demodulating a signal transmitted simultaneously from at least two

antennas and received over a multi-carrier wireless channel;

        a channel estimator for estimating the multi-carrier wireless channel using at least

some pilot signals of the signal received;

        a multi-level signal constellation embodied on a computer storage medium, the signal

        constellation comprising a plurality of points exhibiting a minimum separation D

        between levels given by: $\max\limits_{\substack{C=\{c_1,\cdots,c_M\} \\ \frac{1}{M}\sum\limits_{i=1}^{M}|c_i|^2\le P_{av}}}\min\limits_{i\ne j}D\left(c_i\|c_j\right),$

wherein i and j are integer indexes, C is the signal constellation, c_i and c_j are

constellation points, M is the total number of constellation points in the constellation, and P_{av}

is one of an average constellation power, a ratio of signal power to noise power, a ratio of bit

energy to noise power spectral density, or a ratio of symbol energy to noise power spectral

density; and

        computer code embodied on a computer storage medium for matching a symbol of the

signal received to the signal constellation.

18.   (original) A method of transmitting a signal over a multi-carrier system comprising:

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mapping a signal to be transmitted to a signal constellation, the signal constellation defining a plurality of C constellation points and $n=2M$ real dimensions, wherein the C points are disposed about at least two mutually exclusive subsets such that a separation between two nearest constellation points of adjacent subsets is based on a maximized minimum difference between conditional probability distributions;

adding pilot symbols to the mapped signal;

modulating the pilot symbols and the mapped signal in accordance with a multi-carrier modulation technique; and

transmitting the modulated pilot symbols and the mapped signal simultaneously from at least M transmit antennas, wherein M is an integer at least equal to two.

19.   (original) A method for decoding a signal received over a multi-carrier system comprising:

receiving a set of signals that were transmitted from at least M transmit antennas from a multi-carrier channel, wherein M is an integer at least equal to two;

using a portion of the set of signals to estimate channels of the multi-carrier system; and

decoding at least a portion of the set of signals by mapping them to a signal constellation, the signal constellation defining a plurality of C constellation points and $n=2M$ real dimensions, wherein the C points are disposed about at least two mutually exclusive subsets such that a separation between two nearest constellation points of adjacent subsets is based on a maximized minimum difference between conditional probability distributions.

20.   (original) The method of claim 19 wherein decoding the set of signals comprises separately determining which subset and which point of a subset a particular symbol within the set of signals best matches.

21.   (original) The method of claim 19 wherein the difference between conditional probability distributions is a Kullback-Leibler distance.

22.   (original) The method of claim 19 further comprising selecting a proper signal constellation such that a signal to noise ratio defined by the received set of signals is equal to or greater than a sum of the squares of the absolute value of each constellation point divided by C.

23.   (original) The method of claim 19 wherein each of the mutually exclusive subsets define a concentric sphere.

24.   (original) The method of claim 19 wherein mapping at least a portion of the set of signals to the signal constellation comprises determining a conditional probability distribution of each symbol within the at least a portion of the set of signals.

25.   (currently amended) The method of claim 24 wherein the conditional probability distribution is

$$p(X_i|S_i,\hat{H}_i) = E_{\tilde{H}_i}\{p(X_i|S_i,\hat{H}_i,\tilde{H}_i)\} = \frac{1}{\pi(\sigma^2 + \sigma_E^2\|S_i\|^2)}\exp\left\{-\frac{\|X_i - S_i\hat{H}_i\|^2}{\sigma^2 + \sigma_E^2\|S_i\|^2}\right\}$$

that is maximized over at least two possible values for S_i for each symbol and wherein.S_i comprises a transmitted signal vector, $\hat{H}_i$ comprises a channel estimate matrix, X_i comprises a received signal vector, and $\tilde{H}_i$ comprises an estimation error matrix at an ith frequency bin.

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